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UNITED STATES
DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
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MINING AND MILLING METHODS AND COSTS OF THE GOLDEN ANCHOR MINING CO., BURGDORF, IDAHO

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BY

S. H. LORAIN AND W. BUFORD DAVIS

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MINING AND MILLING METHODS AND COSTS OF THE GOLDEN ANCHOR MINING CO., BURGDORF, IDAHO[1/]

By S. H. Lorain[2/] and W. Buford Davis[3/]

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INTRODUCTION

This paper is one of a series on mining and milling methods and costs being published by the Bureau of Mines. It describes the operations at a successful small-tonnage gold mine in one of the newer and more inaccessible mining districts of central Idaho.

LOCATION

The Golden Anchor mine is in the Marshall Lake mining district, Idaho County, Idaho. It is 50 miles by road north and a little east of the nearest railroad point at McCall, Idaho, and 17 miles north of the nearest post office at Burgdorf, Idaho, in the high mountains of central Idaho; the region has been opened to automobile travel only within recent years. The mine is on the south slope of the main Salmon River canyon at an altitude of 6,500 feet, and 4,500 feet above the Salmon River.

HISTORY

The vein was discovered in 1914 by a man named Fox who sold it to L. T. Holte. Holte drove the adit now known as the 200-foot level, built a camp and mill, and mined the ore above this level; he then sank a shaft to the 300-foot level but ran into financial difficulties. The Golden Anchor Mining Co. was then organized; a 1,600-foot crosscut adit was driven and the vein cut on the 600-foot level. In 1932 the United Verde Extension Mining Co. purchased a controlling interest and developed the mine intermittently until the summer of 1935, when a 50-ton mill was constructed at the portal of the 600-foot level crosscut. A production of approximately 30 tons a day has been maintained since the completion of the mill.

CLIMATE AND VEGETATION

The climate is characteristic of the high mountains of central Idaho; the summers are cool and short, the winters long and cold; a winter temperature of 40° below zero is recorded frequently. Snow may fall during any month of the year; at the altitude of the mine it covers the ground from November to May, inclusive; on the nearby higher ridges and in sheltered valleys the winter snow does not melt until late June or early July.

Although the country is rugged and the mountain slopes are steep, there is in most places a thick covering of soil, which often renders prospecting difficult. Timber suitable for mining purposes grows abundantly in the stream valleys and on the less precipitous slopes.

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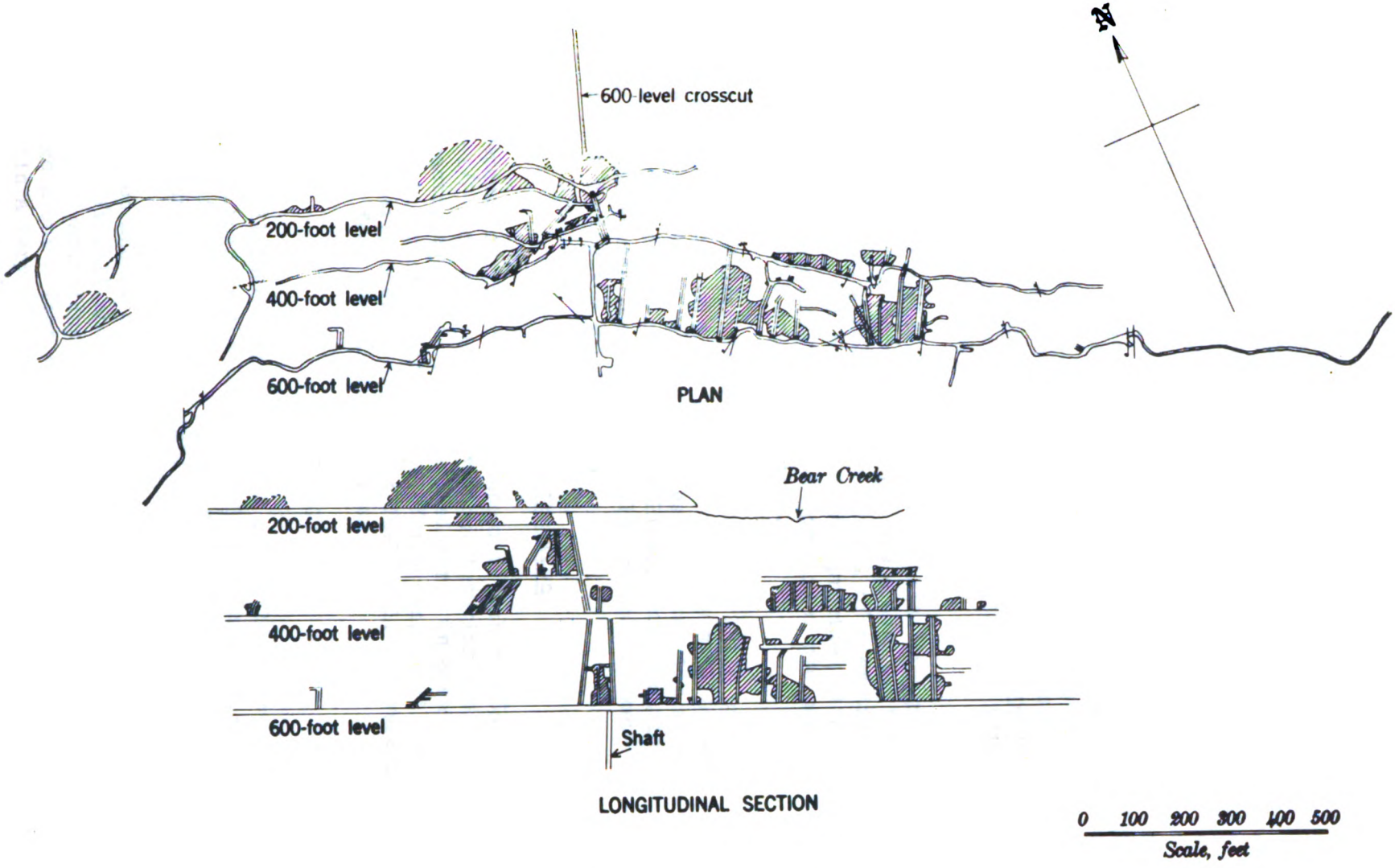

Figure 1.—Underground workings, Golden Anchor mine.

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TRANSPORTATION

The mine is reached from the railroad at McCall, Idaho, by 38 miles of graded dirt road and 12 miles of narrow, ungraded mountain road, which crosses an 8,000-foot summit; it is closed to wheeled motor travel for seven months of the year. The road from McCall is nowhere less than 5,000 feet above sea level and is entirely closed to wheeled motor travel for about 5 months of the year. During the winter, a regular mail and passenger service is maintained between Burgdorf and McCall by a tractor-drawn sled; however, no effort is made to maintain regular communication between Burgdorf and the mine except by foot travel or dog team. In emergencies, a caterpillar "22" tractor owned by the mining company has hauled a sled and 4,000 pounds of supplies from Burgdorf to the mine in one day after the trail had been broken. In the summer of 1936 an emergency winter landing field was cleared near the mine to facilitate the air transport of sick or accident cases to the hospital.

Food and other supplies sufficient to last through the seven winter months must be stocked before the roads are closed in the fall; this requires careful planning and accurate control of operations to insure against enforced shutdowns. Since the mine is not provided with cold-storage facilities, animals to supply fresh meat for winter use must be brought in on the hoof and fed until freezing weather.

At present a Forest Service road is being built up the Salmon River canyon from Riggins; in a few years it probably will be possible to build a tractor trail or truck road 8-1/2 miles long from the mine to connect with the Forest Service road on the Salmon River, thus greatly lengthening the transportation season; such a road could probably be kept open without excessive cost during the entire year.

Road Construction

In preparation for ultimate connection with the Salmon River road, 2 miles of 6-1/2-foot tractor trail was built during the summer of 1937 with the "22" tractor equipped with an angledozer. On open side-hill construction this small tractor, with a crew of two men, built 800 feet of trail per day at a daily cost of $11.50 for fuel, oil, and wages. The excavation averaged 3-1/2 feet deep on the inner side.

GEOLOGY

The Marshall Lake mining district is in the heart of a great mass of granitic rock known as the Idaho batholith. In the vicinity of the mine are a number of small areas of schist and gneiss, which apparently are remnants of the pre-Cambrian rock into which the batholith was intruded.

The Golden Anchor ore occurs in a quartz vein that has a general strike of N. 50° E. (fig. 1) and a dip of about 50° southwesterly; however, there are many local variations in strike and dip. The ore-bearing parts of the vein average about 2 feet wide; however, the width may vary from 8 to 36 inches within a very short distance. Both walls of the vein may be schist, gneiss, or quartzite; in other places one wall may be quartzite and the

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other wall schist or gneiss. The planes of foliation of the schist and gneiss strike at right angles to the vein and dip 30° to 60° westerly. The vein is always stronger where one wall is schist or gneiss; where both walls are quartzite it often becomes a mere slip plane carrying very low values. Gangue is almost entirely absent along the productive ore shoots.

The vein is cut by a series of faults, most of which strike North 30° to 60° East and dip 30° to 70° northwesterly. These faults displace the vein from a few inches to 50 feet horizontally; most of them are evidently premineral and have had a strong effect on the localization of ore shoots. In many cases the ore shoots have apparently been localized by damming of the mineralizing solution below the intersection of a northeast fault with the vein fracture. It is also noticeable that the strongest ore bodies are formed in those parts of the vein fracture where the fault movement has been strong and nearly at right angles to the vein fracture; on the other hand, there is relatively little ore where the fault movement is weak or forms an acute angle with the vein fracture. Furthermore, the ore usually is cut off abruptly against the right angle faults but pinches out gradually as it approaches those faults that intersect the vein at more acute angles. These facts suggest the assumption that the vein fracture was formed by the tensional stresses set up by movement along the northeast faults, with the result that the strongest ore bodies are in those parts of the fracture subject to the least shearing and the greatest direct tensional movement.

Oxidation has been strong near the surface and has continued along certain channels to the lowest workings; the surface ores and percolation channels are often stained with cerargyrite, malachite, and ferrous sulphate. In the lower levels, sulphide mineralization consists of tetrahedrite, galena, sphalerite, molybdenite, and pyrite with free gold. There is considerable scheelite in the upper workings. The ratio of silver to gold in the upper workings is about 2 to 1; in the lower levels this ratio rises to 4 to 1 and sometimes is as high as 20 to 1. It is believed that this erratic distribution of silver is due to solution (and subsequent precipitation) by downward percolating surface waters.

DEVELOPMENT AND MINING

Development Openings

The mine is developed through a 1,600-foot adit crosscut to the vein on the 600-foot level and through several shorter adits on the upper levels.

On the main or 600-foot level are 2,400 feet of drifting on the vein in Golden Anchor ground and an additional several hundred feet in adjoining Sherman-Howe ground. Four other levels of varying lengths develop the vein between the 600-foot level and the surface. These levels have been driven at intervals of 45 to 200 feet; on the basis of past experience it is now planned to drive future levels at 120-foot intervals, measured along the vein.

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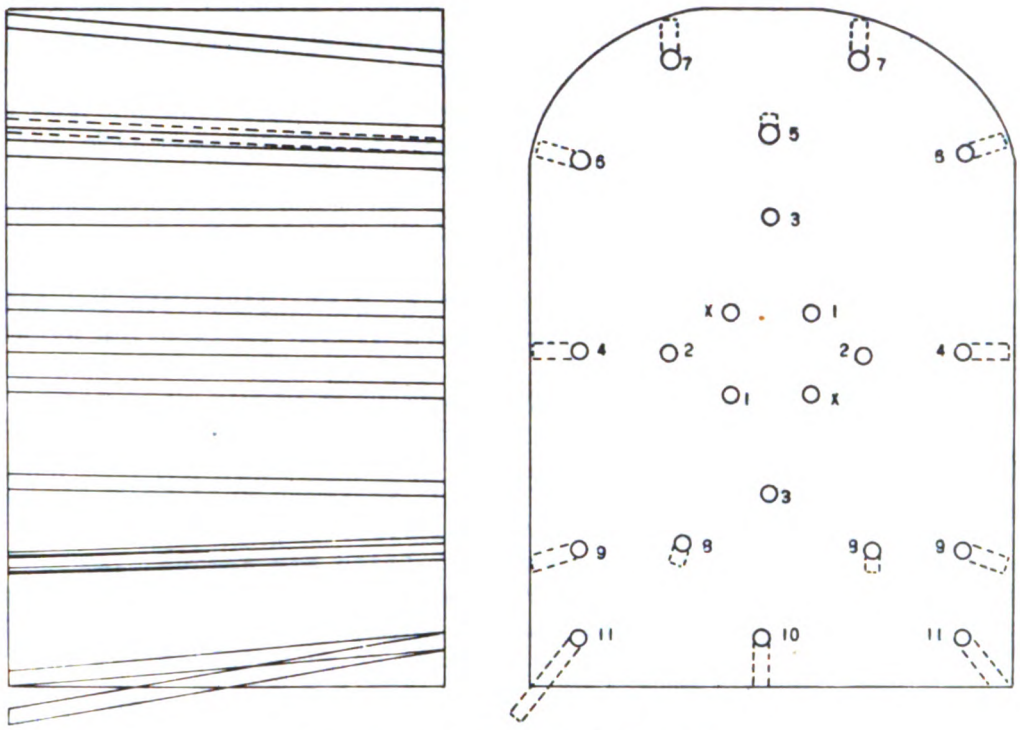
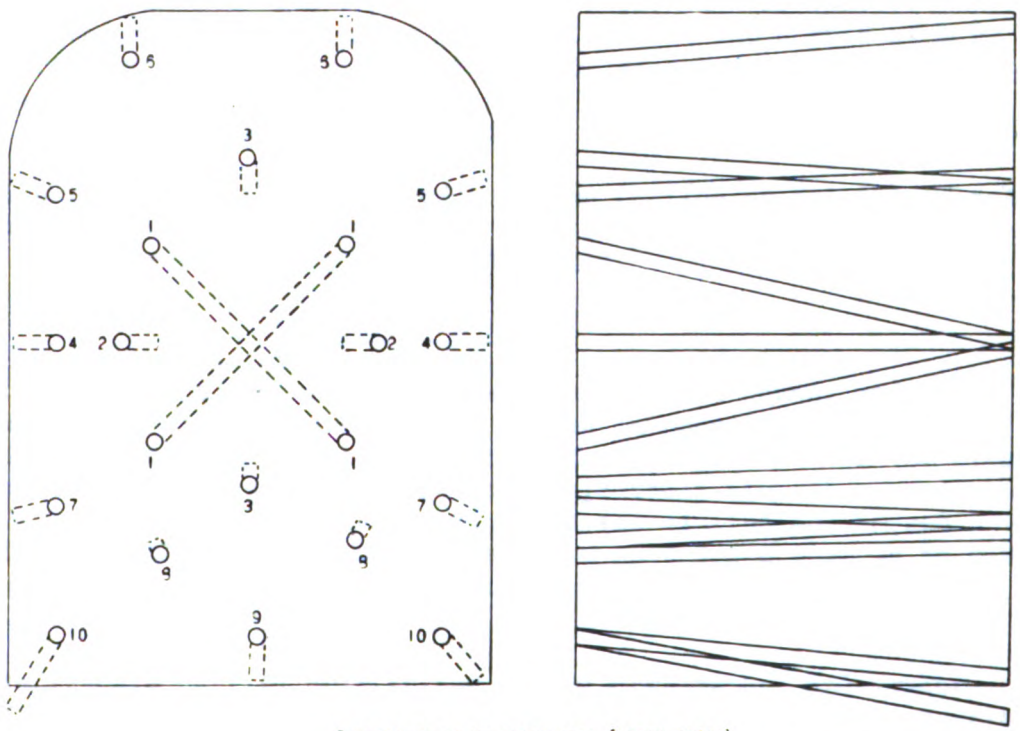


Burn-cut round (numbers show firing order)



Pyramid round (numbers show firing order)

0 1 2 3 4

Scale, feet

Figure 2.- Drift rounds at Golden Anchor mine.

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During 1937 a 2-compartment vertical shaft was sunk about 200 feet vertically (equivalent to 260 feet on the vein) below the 600-foot level. The shaft cut the vein approximately half-way between the 600- and 800-foot levels. The skip compartment is 4-1/2 by 5 feet and the manway compartment is 4-1/2 by 3 feet in the clear.

Drifting Methods

Drifts and crosscuts are 5 by 7 feet in cross section. Crosscuts are nearly always untimbered; drifts must frequently be timbered with full sets when going through broken ground, but in ordinary ground they may be untimbered or the back may be supported with an occasional stull. Stope filling usually is supported entirely on stulls.

Ingersoll-Rand L-74 drifters, using 1-1/8-inch round lugged steel, are used for drifting; bit gages start at 1-7/8-inch and are reduced by 1/8 inch for each change. Rounds are drilled by one miner on day shift and are mucked out by one mucker on night shift; an average of 4.25 feet is broken per round drilled. The average advance per day is 3.75 feet, including all delays. Nearly all drifting is on company account.

The number of holes per round varies from 12 in soft ground to 22 in hard ground in drifts and in crosscuts. A "toe" cut is used in soft ground; in hard ground a pyramid cut or burned cut is used. The burned cut is found to be particularly advantageous in blasting hard ground near timber; the two diagonally opposed holes of a four-hole cut drilled at the corner of a 9-inch square are each loaded with 8 sticks of 60-percent gelatin and blasted simultaneously; the other two cut holes, x - x, are not loaded. The two types of drift round are illustrated in figure 2.

In most drift rounds an average of 5 sticks (1-1/8- by 8-inch) of gelatin dynamite is used per hole; 40-percent strength is used in soft and ordinary ground, 60-percent strength in hard ground.

Raising Methods

All raises have two compartments; one is used for a manway and supplies, the other for an ore chute. A few raises in especially favorable ground are stulled and lagged; each compartment is 3 by 4 feet in the clear. All other raises are cribbed with 4-1/2-inch half-round timber; each compartment is 3 by 3 feet in the clear. Although the stulled and lagged raises require less timber, careful cost studies have shown them to be more expensive in over-all costs than the cribbed raises, which require less labor.

Stope raises are carried up with the stope; development and exploratory raises are driven with hand-rotated Ingersoll-Rand N 79 stopers using 1-inch quarter-octagon steel. Because of the isolation of the mine and the consequent difficulty of obtaining spare parts in emergency, the comparative mechanical simplicity of the hand-rotated stoper is considered to outweigh the advantages of the self-rotated stoper.

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A 5-foot round is pulled with 15 holes, using a V-cut; the usual powder charge is 5 sticks of 40-percent-strength gelatin dynamite to the hole. One miner and a helper drill and blast one day and timber the next; this results in an average of 2-1/2 feet per day.

Sinking Methods

Shaft rounds are drilled with Ingersoll-Rand BCRW 430 jackhammers using 7/8-inch hexagon steel in soft ground; in hard ground an L 74 drifter fitted with "plugger" handles is used. Rounds 3-1/2 feet deep are pulled by a round of 24 holes, using a V-cut; the holes are arranged in 8 rows of 3 holes each, the two center rows constituting the cut. The usual powder charge is 90 sticks of 40-percent gelatin dynamite per round; all shaft rounds are fired electrically.

Two miners drill and blast a round on day shift and two muckers clean out the round on night shift; timber sets on 6-foot centers are placed in two shifts. This results in an average advance of approximately 2-1/2 feet per day.

Locally cut Douglas fir is used for shaft timbers; wall plates and posts are 8 by 8 inches and dividers 8 by 6 inches in section.

Stoping Methods

Ore is broken by resuing in flat-back cut-and-fill stopes as illustrated in figure 3. Stopes are started directly from the drifts; the stope fill is supported on 8-inch stulls placed 5 feet apart and covered with 3-inch round or sawed lagging. Another row of stulls, without lagging, is placed 5 feet above the first row for the purpose of arching the fill and relieving the load on the drift timbers; stulls in the second row are staggered with relation to those in the first row.

Two compartment cribbed raises spaced about 35 feet, center to center, or 30 feet from inside to inside of the ore compartment are carried up with the stope. One compartment is used for ore, the other for men and supplies. Tugger hoists with 3/8-inch steel cables are used to hoist supplies in small steel skips running on wooden slides in the manway compartment.

Stopes are carried 4 feet wide, measured at right angles to the vein; inasmuch as the vein averages about 2 feet wide, the ore and waste usually are broken alternately by resuing. In 65 to 70 percent of the working faces the ore is first broken onto overlapping steel mucking plates and shoveled into the ore raise; the plates are then taken up and either the hanging-wall or footwall broken and allowed to lie for stope filling; in other places the process is reversed by breaking the waste first; ore is carefully sorted in the stopes. Occasionally, where the vein is exceptionally wide, it is necessary to place extra shots in the footwall to fill a stope.

Stope filling is kept within about 6 feet of the face; an occasional stull is required to support weak sections of the hangingwall until a stope is filled. It is seldom, if ever, necessary to draw waste from the stopes, nor is filling brought into stopes from other working places.

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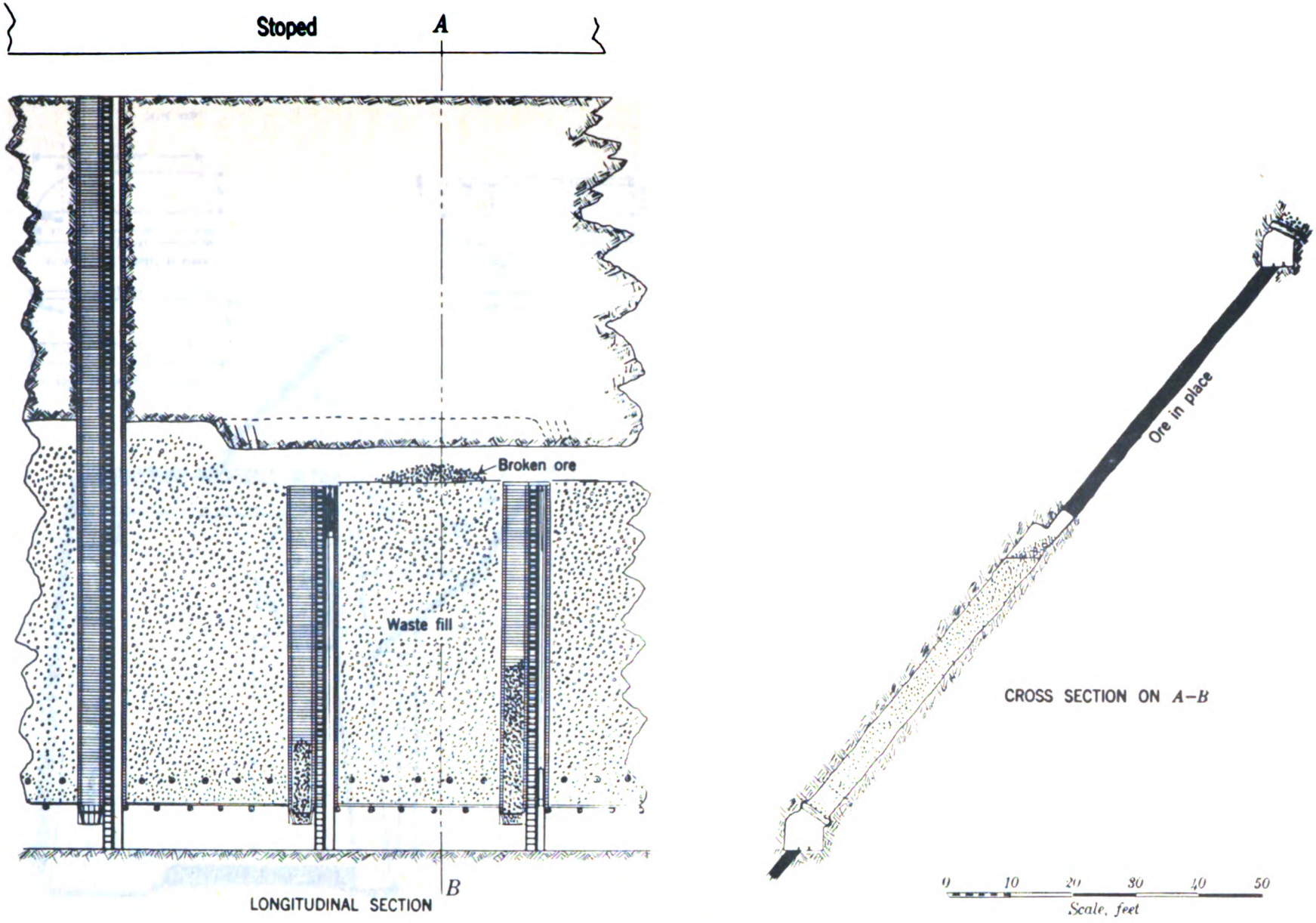

Figure 3.—Stoping method at Golden Anchor mine.

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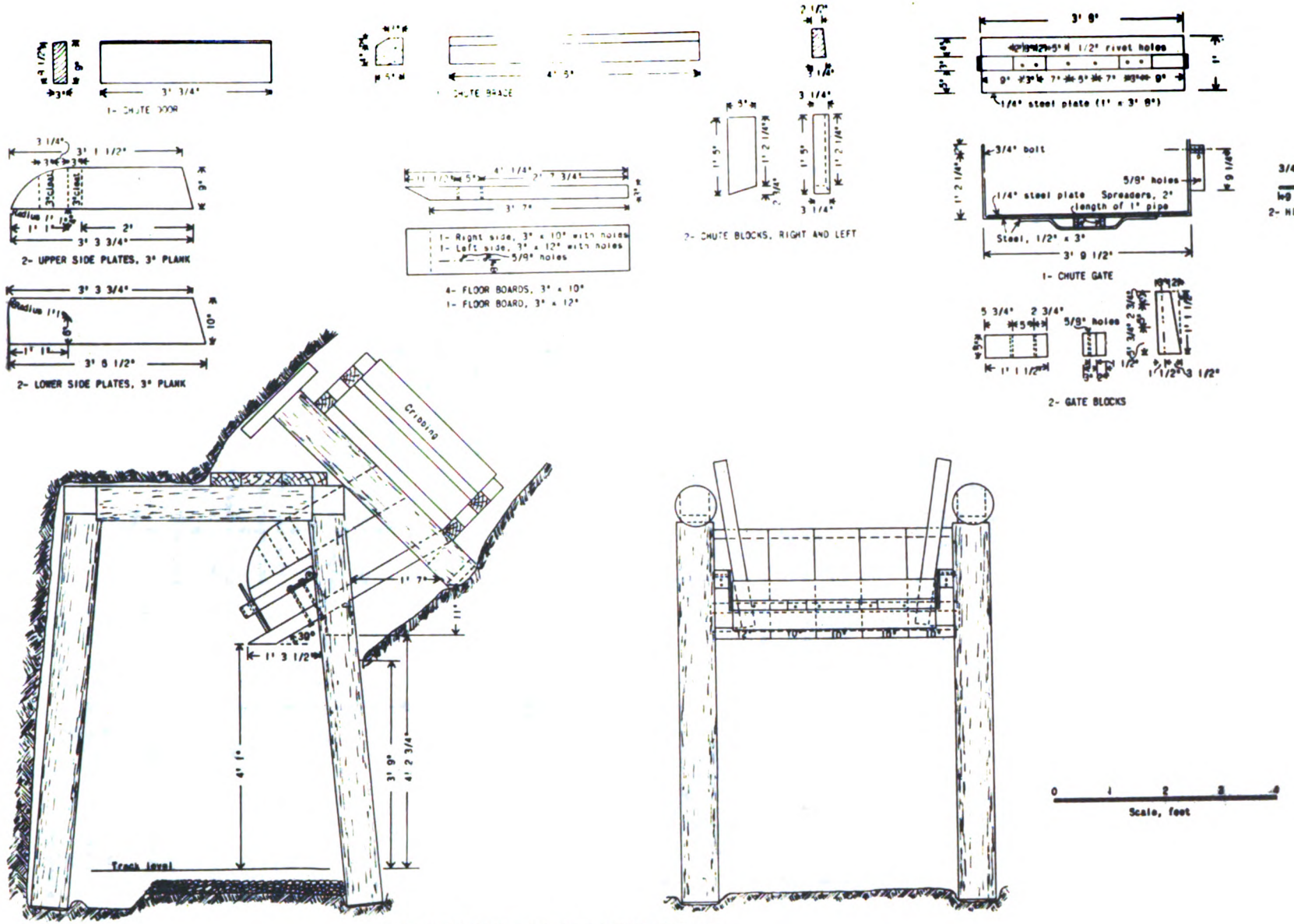
1- CHUTE DOOR
1- CHUTE BRACE
2- CHUTE BLOCKS, RIGHT AND LEFT
1/4" steel plate (1' x 3' 8")
2- HINGES
2- UPPER SIDE PLATES, 3" PLANK
4- FLOOR BOARDS, 3" x 10"
1- FLOOR BOARD, 3" x 12"
1- CHUTE GATE
2- LOWER SIDE PLATES, 3" PLANK
2- GATE BLOCKS
Grizzly
Track level
Scale, feet

Figure 4.- Details of chute construction, Golden Anchor mine.

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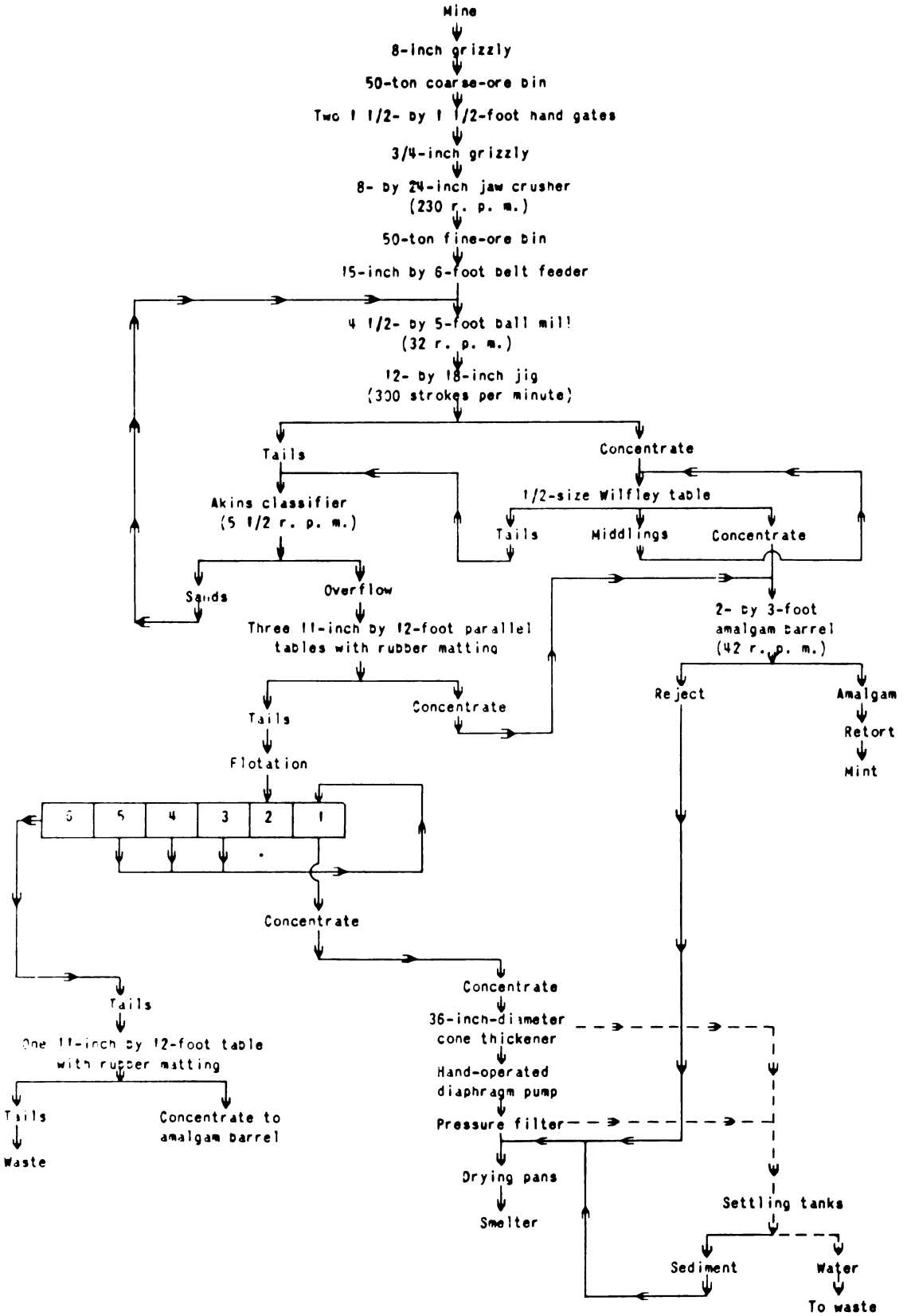

Figure 5.- Flow sheet, Golden Anchor mill.

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Each miner, assisted by a mucker, does all drilling, timbering, and other work required in his working place. Hand-rotated stopers are used, as in raising; an average of eight 4-foot holes are drilled and blasted per machine shift; the usual powder charge is three sticks of 40-percent-strength gelatin dynamite per hole. In some working places blasting is done twice a shift; all drilling and blasting is done on day shift. Inasmuch as there is insufficient air to operate all drills at the same time, drilling time is alloted to each miner by the shift boss.

On the main level, steel and other supplies are delivered to the stopes and transfer raises by the motorman. Supplies for the upper levels are hoisted through the transfer raise by the hand trammer and distributed by him to the stope raises. The main transfer raise is an old stope raise extending to the 400-foot level; this raise has been equipped with a small skip running on a 24-inch-gage track and pulled by an air hoist. Stope miners or muckers take their supplies from the bottom of the stope raises.

Tramming

Ore from the upper levels is trammed to a transfer raise by hand in 20-cubic-foot-capacity cars. On the main or 600-foot level a Mancha "little trammer" pulls a train of 12 cars of 16-cubic-foot capacity each. Up to 50 cars of ore are trammed on day shift and about 50 cars of waste on night shift. One motorman on each shift pulls all ore chutes on the main level or trams waste from development and handles all supplies.

Chutes are 3 feet wide at the lip and flare to a width of 4 feet at the back, as illustrated in figure 4; they are built of 3-inch plank throughout. A simple and efficient steel chute gate, which may be made by any blacksmith (fig. 4), can be operated safely and quickly by the trammer standing at one side of the chute and inserting a bar in the handle shown in the sketch.

Sampling

Development faces are sampled at 5-foot intervals by channels samples taken by the manager. Stope faces are sampled only when there is a doubt as to their value. A careful check of the results of channel sampling against actual mill recoveries plus tailings assay indicated a dilution of 7.1 percent by value.

MILLING METHODS

Ore is treated in a 50-ton amalgamation-flotation mill operated two shifts a day. The flow sheet is shown in figure 5.

Ore from the mine is received in a 50-ton bin covered with an 8-inch grizzly on which oversize is broken by hand. Two hand-operated gates control the flow of ore from the coarse-ore bin onto a grizzly with a 3/4-inch space between the bars. The oversize is crushed in an 8- by 24-inch Allis-Chalmers-Blake type jaw crusher run at 230 rotations per minute, set for 1/2-inch discharge. Crushed ore and grizzly undersize fall into a 50-ton fine-ore bin.

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From the fine-ore bin the ore is fed by a 15-inch by 6-foot Denver belt ore feeder traveling at 18 inches per minute to a 4-1/2- by 5-foot open discharge ball mill loaded with forged-steel balls of 3-inch maximum size. The ball mill is lined with wave-type liners and is operated at 32 rotations per minute, through a Texrope drive. It is operated in closed circuit with a 12- by 18-inch Denver mineral jig and an Akins classifier. The jig pulsates at 300 strokes per minute and the classifier rotates at 5-1/2 rotations per minute. A jig bed 2 inches deep, composed of 3/8-inch ball bearings, has been found much more satisfactory than the shot bed originally used. About 15 pounds of jig hutch is drawn on each shift, and the jig concentrate is run over a half-size Wilfley table, which produces a tail, middling, and concentrate; the middling is accumulated and run over the table again and the tails from the two runs are returned to the classifier. Concentrates from both runs and middling from the second run are amalgamated in the amalgam barrel.

Classifier overflow passes over three 11-inch by 12-foot tables arranged in parallel and covered with rubber matting; tables slope 1-1/4 inches per foot. Concentrates are removed from the matting every two days and amalgamated in the amalgam barrel with the jig concentrates.

The amalgam barrel is operated when sufficient concentrates have accumulated, usually about twice a month. The concentrates are ground for 6 hours with mercury, lye, and about a dozen 4-inch steel balls. The amalgam is retorted, and the rejects, which assay about 14 ounces of gold to the ton, are shipped to the smelter.

Tails from the blanket tables are fed to the second cell of a 6-cell, 15-inch, Denver sub-A flotation machine; this cell is used as a conditioner only. The pulp then goes to the last four cells in series; the concentrates from these cells are returned to the first cell for cleaning. Reagents are added to the feed to the conditioner cell by a Denver reagent feeder in the quantities shown in the table under the section on Metallurgical Data. Soda ash was used formerly but was definitely found to depress gold; consequently, its use was discontinued; the present flotation circuit is virtually neutral.

Flotation concentrates from the first cell are thickened in a 36-inch diameter cone, from which the pulp is discharged by a hand-operated diaphragm pump and filtered in a pressure filter of local design and construction. The filter consists essentially of a round iron box 18 inches in diameter and 18 inches high, in the bottom of which is a spirally grooved plate covered with filter cloth. The box is nearly filled with concentrate, air pressure is applied, and the moisture is forced out through the spiral grooves. The filtered concentrate contains 10 percent moisture; it is then dried more thoroughly in pans and sacked for shipment in lined sacks of 100 pounds capacity with cemented ends.

The sacked concentrates are trucked 17 miles to Burgdorf in 3-ton loads; they are then reloaded in 10-ton trucks and hauled the remaining 550 miles to the smelter at Garfield, Utah. The total cost of trucking from the mine to the smelter is $26 per ton of concentrate.

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Metallurgical data for 1937

	Gold	Silver
Head assay, ounces per ton	0.711	2.583
Tail assay, ounces per ton	.0488	.670
Tons crushed per hour of crusher operation		7.908
Tons milled per hour of mill operation		2.025

Reagents per ton of ore milled:

	Pounds per ton of ore
Aerofloat No. 25	0.298
Xanthate Z-3	.224
Pine oil	.099
Forged steel balls	3.55

Sample screen analysis of tails

Mesh	Percent	Gold	Assay (ounces/ton silver)
On 60	0	0	0
Through 60, on 100	2.44	Trace	Trace
Through 100, on 200	34.10	0.03	1.48
Through 200	63.46	.07	2.92

Extraction

Gold:

By amalgamation:	Percent
From jig concentrate	73.3
From table concentrate	2.34
Total	75.64
By flotation:	17.39
Total	93.03

Total extraction, gold and silver, for 1937:

Gold	93.03
Silver	80.71

Ratio of concentration ..... 272.42 to 1.

Sample concentrate assay

	Ounces per ton
Gold	36.45
Silver	537.8
	Percent
Lead	4.5
Copper	1.3
Moisture	5.6

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GENERAL OPERATING DATA

Labor

Average labor distribution for 1937:

Mining:	
Exploration and development:	
Miners on drifting and raising	4
Muckers on drifting and raising	4
Miners in shaft	2
Muckers in shaft	3
Hoistmen for shaft	2
Outside prospecting (hand mining)	4
Total	19
Stoping (including tramming):	
Miners in stopes	5
Muckers in stopes	5
Muckers on general mine labor	3
Hand trammers (on upper levels)	1
Motormen	2
Shift boss	1
Total	17
Outside labor:	
Blacksmith	1
Compressor and warehouse man	1
(Millman takes care of compressor on night shift)	
Timber framer	1
Power plant operators	3
General surface labor	2
Total	8
Milling:	
Crusherman	1
Mill foreman - operator	1
Mill operator	1
Total	3
General supervision:	
Manager	1
Assayer, engineer, bookkeeper	1
Total	2
Total on direct operation	49

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Wage Scale

The following wage scale was in effect in September 1937:

	Per shift
Miners	$5.50
Muckers	5.00
Motormen	5.50
Timber framers	5.00
Shaft miners	5.75
Hoistmen	5.50
Millmen	5.50
Crushermen	5.00
Blacksmith	5.50
Compressormen	5.00
Outside labor	4.40
Power-plant operators	5.50

Power

Power requirements

Connected power:

Mine:	Horsepower	
Compressor, single-stage Chicago Pneumatic, 200-cubic-foot capacity	50	
Compressor, 2-stage, 8- by 10-inch, 14- by 10-inch, 460-cubic-foot capacity at elevation of mine (6,500 feet)	75	
Underground hoist motor driving Eimco hoist, 5,000-pound rope pull at 150 feet per minute	25	
Battery charger	5	
Wedge and cribbing saw	5	
Centrifugal pump	15	
Total mine		175
Outside:		
Sawmill driven by take-off from tractor		
Mill:		
Crusher	25	
Feeder	1/2	
Ball mill and jig	50	
Classifier	1-1/2	
Flotation (three 3-horsepower motors)	9	
Miscellaneous	6	
Total mill		92
Total connected		267

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Power consumption: - A metered record of power consumption is not kept. The usual load at the power house is 175 horsepower on day shift, 182 horsepower on afternoon shift, and 112 horsepower on night shift. This gives an approximate daily power consumption of 2,799 kilowatt hours, or about 91.66 kilowatt-hours per ton mined and milled. These power requirements are figured on the basis of operation in late 1937 and include shaft development.

Power Supply

Power is obtained from a power plant 4 miles from the mine. This plant was built originally for a neighboring mine but is now leased by the Golden Anchor Mining Co. Power is generated by a Rathbun-Jones Diesel engine direct-connected to a 175 kilowatt generator; the Diesel has a sea-level rating of 250 horsepower; at the elevation of the power plant (6,000 feet) it develops 212 horsepower. Power is transmitted at 2,200 volts and is reduced to 440 volts at the mine.

Cost of Power Generation

The plant consumes an average of 5,500 gallons of fuel oil per month and requires the attendance of three operators when operating three shifts a day. The following table gives the cost of generating power, in cents per kilowatt hour:

Labor	0.548
Supplies	.045
Fuel oil	.760
Rents	.226
Total	1.579

Timber and Firewood

Timber and firewood are cut locally and sawed at the mine; native pine and fir are used for most purposes.

Mine timber is cut in 16-foot lengths with 6-inch tops at a contract price of $5 a cord; the larger pieces are sawed into lumber and the rest is cut and framed for various mine purposes.

Sawing and framing are performed in a shed at the mine portal by the timber framer assisted, when sawing lumber, by an extra man as off-bearer. With the American No. 1 sawmill driven by the caterpillar tractor, two men can saw 8,000 feet of lumber per day with a fuel consumption of about 10 gallons of gasoline. The direct cost of rough-sawed lumber is approximately as follows:

	Per 1,000 board feet
Cut and deliver 1,000 board feet (about 1-1/4 cords at $5 a cord)	$6.25
Gasoline, 1.25 gallons at $0.19, delivered	.24
Labor, 2 men 1/8 of a day	1.25
Total direct	7.79

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Slabs from sawmill operation are used for lagging and cribbing; however, they are not included in the 1,000 board feet on which the above cost is based.

This compares with a cost of $27 a thousand for lumber delivered from the nearest commercial sawmill.

In the fall, 400 cords of mine timber is laid in for the winter's supply. About 50 cords of wood is required to heat the mill during the winter. This wood is cut and delivered on contract in 5-foot lengths at a cost of $5.50 a cord. About 35 cords of wood is required for the cook house during the year; during the same period, about 215 cords is required to heat the two bunkhouses, 10 family cabins, manager's office, engineering office, and assay office. This wood is cut and delivered in 18-inch lengths at a contract price of $6 a cord.

Cost of Freight and General Mining Supplies

The cost of the principal mining supplies delivered to the mine in 1937 was as follows:

Dynamite;	
40-percent strength	$13.54 per 100 pounds.
60-percent strength	15.34 do.
Fuse	6.19 per 1,000 feet.
Caps	1.313 per 100.
Fuel oil	0.11 per gallon.
Timber (see section on timber and fire wood)	

Miscellaneous supplies cost the regular city prices plus a freight charge of $0.90 a hundred from Boise (176 miles); or $0.50 a hundred from McCall (47 miles).

OPERATING COSTS

The following costs are averaged for 1937. During this period 9,546.63 tons of ore was mined and milled, 11,243 tons of waste trammed, and 2,933.11 feet of development drifting and raising completed. A shaft was also started and sunk 200 feet; sinking costs, however, are not included in the per-ton costs given below. Liability insurance and social-security taxes are included in the costs given; other taxes, depreciation, depletion, etc., are not included.

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Mining Costs Per Ton of Ore Mined

Item	Stoping	Development [1]	Mine maintenance	Total
Labor	$2.40	$1.83	$0.06	$4.29
Explosives	.20	.24		.44
Timber	.07	.04		.11
Power and air	.31	.27		.58
Other supplies	.37	.37		.74
Liability insurance	.12	.09		.21
Overhead [2]	.31	.31		.62
Total	3.78	3.15	0.06	6.99

1/ Includes tramming.
2/ Includes supervision, assaying, engineering, office, and social-security taxes.

Milling Costs Per Ton of Ore Milled

Labor	$0.57
Power	.72
Wood for heat	.03
Other supplies	.47
Maintenance	.02
Express and mint (bullion)	.13
Freight and smelter (concentrates)	.15
Overhead [1]	.61
Total	2.70

1/ Includes supervision, assaying, engineering, office, and social-security taxes.

Summary of Mining and Milling Costs

	Per ton
Mining:	
Development	$3.15
Stoping	3.78
Maintenance	0.06
Total	6.99
Milling	2.70
Mining and milling	9.69

Cost of Sinking, Per Foot [1]

Labor	$32.34
Explosives	2.82
Power and air	4.51
Timber	.59
Other supplies	1.92
Liability insurance	1.61
Total	43.79

1/ Based on cost of sinking approximately 200 feet. This does not include cost of equipment or preparation but does include a heavy pumping cost. Operations were generally handicapped by heavy water flow.

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Operating Costs in Units of Labor, Power, and Supplies

Mining

Item	Development (exclusive of sinking)	Stoping	Total
Labor, man-hours per ton:			
Drilling, blasting, and timbering	0.89	1.52	2.41
Mucking	.89	1.72	2.61
Tramming	.28	.26	.54
Supervision	.26	.26	.52
General[1]	.33	.34	.67
Total	2.65	4.10	6.75
Average tons per man-shift	0.467	0.723	1.19
Power and supplies:			
Explosives, pounds per ton:			
40-percent strength	1.08	1.49	2.57
60-percent strength	.26	--	.26
Total	1.34	1.49	2.83
Timber, board feet per ton	200	257	457
Power, kw.-hrs. per ton	2/22.15	25.10	47.25
Other supplies, percent of total supplies and power	40.21	38.90	39.5
Total supplies and power, percent of total cost	29.2	25.1	26.8

Milling

Labor, man-hours per ton milled:	
Crushing	0.17
Operating	.40
General labor	.02
Total	0.59
Power, kw-hrs. per ton milled	30.23
Reagents, pounds per ton milled	.621
Steel, pounds per ton milled:	
Balls	3.55
Liners	.857
Total	4.407
Wood for heat, cords per ton	.0268

1/ Includes outside labor directly chargeable to underground operation.
2/ Power consumption for sinking was 14.18 kw.-hrs. per ton mined during the period of sinking.

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